Performance Evaluation of Depth Based Routing in Underwater Sensor Networks

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Abstract

Underwater wireless sensor networks (UWSNs) rely on acoustic communication between the sensor nodes and sinks, drawing power from onboard batteries. Since battery replacement may be costly or completely unfeasible for UWSNs, it is crucial that the communication protocols not only take into account various performance metrics, but also the energy efficiency of the protocol. While a thorough understanding of routing protocols is crucial for the operational efficiency of UWSNs, only a few studies propose and analyze stochastic models for assessing and optimizing the performance and energy efficiency of such networks. In this work, we propose a stochastic model for Depth Based Routing (DBR), which is a popular routing protocol for UWSNs. Characteristics of DBR taken into account include transmission delays on the acoustic channel, node mobility and holding times based on the depth differences as defined by DBR.

We propose an algorithm to efficiently calculate various performance indices, including the distribution of the number of hops it takes to send from bottom to surface, the level dependent energy consumption and the mean end-to-end delay. As the model incorporates the impact of node deployment and the high transmission loss of the acoustic channel, it can be used to understand the behaviour of DBR at the network level, for example to assist the network designer to select the DBR configuration parameters which optimize the trade-off between delivery probability, energy consumption and end-to-end delay. Some numerical experiments illustrate our approach.

Keywords: Depth-Based Routing, Stochastic modelling, probabilistic analysis, energy efficiency, underwater sensor networks.